

PATENT ABSTRACTS OF JAPAN

(11) Publication number : 2002-268200

(43) Date of publication of application : 18.09.2002

(51) Int.Cl. G03F 1/08
G03F 7/095
H01L 21/027

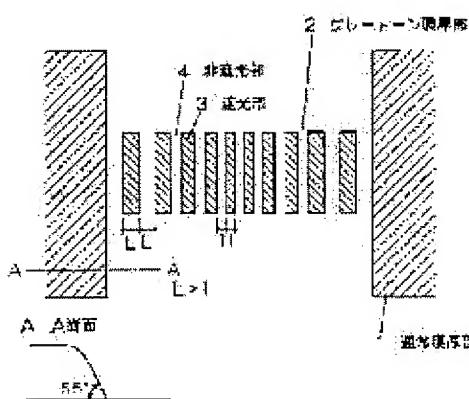
(21) Application number : 2001-068948 (71) Applicant : MATSUSHITA ELECTRIC IND CO LTD

(22) Date of filing : 12.03.2001 (72) Inventor : TAKEGAWA HIROZO

(54) PHOTOMASK FOR GRAY TONE EXPOSURE AND METHOD FOR APPLYING PHOTORESISTIVE RESIN

(57) Abstract:

PROBLEM TO BE SOLVED: To solve the first problem that the taper angle of an ordinary film thickness part becomes smaller near gray tone exposure and the second problem that it is difficult to make gray tone film thickness uniform.



SOLUTION: In order to solve the first problem, the interval between patterns for gray tone exposure is made narrower at the center and wider at the peripheries. In order to solve the second problem, photosensitive resins different from each other in optical sensitivity are applied two or more times and an exposure reaction is accelerated only in the upper photosensitive resin.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

[Claim(s)]

[Claim 1] In the process which faces that ultraviolet radiation performs patterning of a photopolymer, repeats and creates the protection-from-light section and the non-shading section which were formed with the dimension below the resolution of the exposure machine which performs patterning of said photopolymer, and creates two or more thickness of a photopolymer. The part near the part which forms the thickness of the photopolymer usual in the part which repeats said protection-from-light section and the non-shading section is a photo mask for gray tone exposure characterized by the width of face of said protection-from-light section and the non-shading section being wide compared with a far part.

[Claim 2] The ratio of non-shading **** to said protection-from-light **** of a part far from the part near the part which forms the thickness of the usual photopolymer is the same photo mask for gray tone exposure according to claim 1.

[Claim 3] The photo mask for gray tone exposure which prepares the non-shading section of the dimension width of face below the resolution of an exposure machine in parts other than the part which adjoins the part which repeats said protection-from-light section and the non-shading section, and prepares the protection-from-light section of said dimension width of face in them in the part which forms the thickness of said usual photopolymer which uses a positive type photopolymer.

[Claim 4] The photo mask for gray tone exposure which enlarges the dimension of the part which forms the usual photopolymer thickness which faces the part which repeats said protection-from-light section and the non-shading section compared with the part which does not face the part which repeats said protection-from-light section and the non-shading section.

[Claim 5] Said range to enlarge is a photo mask for gray tone exposure according to claim 4 which adjoins the part which repeats said protection-from-light section and the non-shading section, and prepares the die length of the part which repeats said protection-from-light section which touches the part which forms the usual photopolymer thickness at least, and the non-shading section.

[Claim 6] The method of application of the photopolymer characterized by applying a photopolymer with more sufficient optical sensibility than said photopolymer to said substrate side where said photopolymer was applied further after applying a photopolymer to the substrate with which it faced that ultraviolet radiation performed patterning of a photopolymer, and the processed film was formed.

[Claim 7] The method of application of the photopolymer according to claim 6 which applies the solvent of a photopolymer with said sufficient optical sensibility before applying a photopolymer with more sufficient optical sensibility than said photopolymer to said substrate side.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the creation approach of the photo mask for gray tones of changing the permeability of ultraviolet radiation gradually, and the patterning approach which creates two or more thickness of a photopolymer by one exposure using the photo mask for gray tones.

[0002]

[Description of the Prior Art] In recent years, the exposure approach called gray tone exposure is put in practical use. By the conventional exposure approach, patterning of the processed film under it was carried out by one of the part which leaves a photopolymer, and the parts to remove according to the existence of a photopolymer. On the other hand, after gray tone exposure forms the multilayer processed film, in addition to the part which leaves the photopolymer conventional by one exposure, and the part to remove, it tends to create what made thickness of the part to leave thin, tends to carry out patterning of the multilayer processed film at once, and tends to reduce the count of exposure. It is carried out at the process which shows the patterning approach using the photo mask for gray tones below here.

[0003] ** Spreading : apply a photopolymer.

[0004] ** Heat and remove the solvent of the photopolymer prebaked : applied.

[0005] ** Exposure : perform exposure using the photo mask for gray tones.

[0006] ** Development, a rinse : perform development and washing.

[0007] ** Postbake : heat and remove the developer and penetrant remover which remained into the photopolymer.

[0008] Consequently, the part in which the thickness which applied the photopolymer mostly remains, the completely removed part, and the part which left those middle thickness are created. By the pattern below the resolution of the exposure machine to be used, the photo mask of the part made into this middle thickness is constituted, is reducing the ultraviolet radiation to penetrate and is usually equalizing.

[0009]

[Problem(s) to be Solved by the Invention] However, when gray tone exposure was performed, there was a problem that the taper angles of the photopolymer section of thickness usually differed by whether that is right near the gray tone exposure section. As the end face of the usual thickness section which a taper angle is alpha as the end face of the thickness section 1 is usually shown in an A-A cross section, and does not face the gray tone thickness section which 1 is the thickness section, and 2 is usually the gray tone thickness section, and faces the gray tone thickness section 2 by drawing 6 is shown in a B-B cross section, a taper angle is beta and $\beta > \alpha$. For example, if the pattern which repeats the protection-from-light section of the exposure machine resolution of 3 micrometers and 2-micrometer width of face and the non-shading section is exposed using positive type photopolymer OFPR-5000 (Tokyo adaptation make), it will become $\alpha = 60$ degrees and $\beta = 40$ degrees. This is reducing the photopolymer taper angle to the exposure section usual in the effect of diffraction near the gray tone exposure section. If taper angles differ, the dimension shift amount at the time of etching will change, and a workmanship configuration will not become as a design. Moreover, the photopolymer thickness of the gray tone section had the problem of varying in a substrate side. If a positive type photopolymer is taken for an example, and sufficient ultraviolet radiation for a photopolymer is irradiated, a soluble radical will be generated, and it will become alkali soluble, and will dissolve, but since the above-mentioned reaction is inadequate and a soluble radical will not be partially made if there are few exposures of ultraviolet radiation, the homogeneity of the photopolymer thickness after development worsens. If photopolymer thickness is not uniform with a natural thing, process tolerance will worsen. Then, this invention aims at offering the workmanship configuration of the usual exposure section containing the gray tone exposure section, and the photo mask which creates gray tone exposure section thickness to homogeneity and a manufacture process in view of the above-mentioned trouble.

[0010]

[Means for Solving the Problem] In order to attain the purpose which creates the workmanship configuration of the usual exposure section containing the above-mentioned gray tone exposure section to homogeneity In the process which repeats and creates the protection-from-light section and the non-shading section which were formed with the dimension below the resolution of the exposure machine which performs patterning of a photopolymer in the first place, and creates two or more thickness of a photopolymer The part near the part which forms the thickness of the photopolymer usual in the part which repeats said protection-from-light section and the non-shading section is used as the photo mask for gray tone exposure which makes large width of face of said protection-from-light section and the non-shading section compared with a far part, The ratio of non-shading **** to said protection-from-light **** of a part far from the part near the part which forms the thickness of the usual photopolymer in the second is used as the same photo mask for gray tone exposure, In the part which forms the thickness of said usual photopolymer which uses a positive type photopolymer for the third It considers as the photo mask for gray tone exposure which prepares the non-shading section of the dimension width of face below the resolution of an exposure machine in parts other than the part which adjoins the part which repeats said protection-from-light section and the non-shading section, and prepares the protection-from-light section of said dimension width of face in them, It considers as the photo mask for gray tone exposure which enlarges the dimension of the part which forms the usual photopolymer thickness which faces the part which repeats said protection-from-light section and the non-shading section to the fourth compared with the part which does not face the part which repeats said protection-from-light section and the non-shading section, Furthermore, said range to enlarge is considering as the photo mask for gray tone exposure which adjoins the part which repeats said protection-from-light section and the non-shading section, and prepares the die length of the part which repeats said protection-from-light section which touches the part which forms the usual photopolymer thickness at least, and the non-shading section. moreover, in order to attain the purpose which creates gray tone exposure section thickness to homogeneity After applying a photopolymer to the substrate with which the processed film was formed in the first place, a photopolymer with more sufficient optical sensibility than said photopolymer is applied

to said substrate side where said photopolymer was applied further. Before applying a photopolymer with more sufficient optical sensibility than said photopolymer to the second, it is applying the solvent of a photopolymer with said sufficient optical sensibility.

[0011]

[Embodiment of the Invention] (Gestalt 1 of operation) Below, a drawing is used and the example of this invention is explained. Drawing 1 is drawing explaining the pattern of the photo mask for gray tone exposure of the example of this invention. In order to form the gray tone thickness section 2 with thickness thinner than the usual thickness section 1 of a photopolymer by drawing 1, the protection-from-light section 3 and the non-shading section 4 of dimension width of face below the resolution of the exposure machine to be used are repeated. The exposure machine resolution used here set width of face 1 of the protection-from-light section 3 near the center section of 3 micrometers and the gray tone thickness section 2, and the non-shading section 4 to 1 micrometer, and it made 0.5 micrometers of those width of face width of face of $L = 2.5$ micrometers in the increase of every, and the part usually near the thickness section 1 as it went on the outskirts (usually thickness section 1). It was 55 degrees, when 2000A of Ti was formed upwards to the glass substrate, positive type photopolymer OFPR-5000 [1.2-micrometer] were applied, exposure and SEM photography after development were performed and the taper angle of an A-A cross section was measured.

[0012] It is better not to cause the rate of surface ratio of the protection-from-light section 3 and the non-shading section 4 which adjoins here around the center of the gray tone thickness section, but to make it regularity. If the rate of surface ratio changes with locations, gray tone thickness will change and surface smoothness will be spoiled. Therefore, it is usually indispensable to make the same the ratio of the width of face of the protection-from-light section 3 and the non-shading section 4 irrespective of the distance to the thickness section 1.

[0013] (Gestalt 2 of operation) Drawing 2 is drawing explaining the pattern of the photo mask for gray tone exposure which are other examples of this invention. The non-shading section 4 below exposure machine resolution is usually formed in the perimeter of the thickness section 1 by drawing 2, and patterning of the protection-from-light section 3 has been carried out to the periphery. In this example, the non-shading section of 1-micrometer width of face and the protection-from-light section of 1-micrometer width of face are prepared. Consequently, the taper angle of the periphery of the thickness section 1 usually became almost the same also including the part which adjoined the gray tone thickness section 2.

[0014] (Gestalt 3 of operation) Drawing 3 is drawing explaining the pattern of the photo mask for gray tone exposure which is the example of further others of this invention. Drawing 3 enlarges the design dimension of the usual thickness section 1 of the periphery of the gray tone thickness section 2. Although the continuous line has shown as a design dimension 5 conventionally, since the taper angle of the thickness section 1 usually becomes small, the dimension shift amount after etching processing becomes large, and becomes smaller than a design dimension around the gray tone thickness section 2. Therefore, the taper angle of the thickness section 1 needs to enlarge a design dimension in the range which becomes small, and the broken line has usually shown it as a design dimension 6.

[0015] In addition, since it has the effect of gray tone exposure on the usual thickness section 1 of the field of that adjoining die-length m at least when the die length which adjoins the usual thickness section 1 of the gray tone thickness section 2 is m , a design dimension is enlarged in this range.

[0016] (Gestalt 4 of operation) Drawing 4 carries out multiple-times spreading of the photopolymer of the example of this invention, and shows how to equalize gray tone exposure thickness. Drawing 4 (a) applies 6000A (optical sensibility 80 mJ/cm²) of positive type photopolymers to the glass substrate 7 with which SiN was formed as processed film 1 and it formed 1500A of a-Si as 3000A and processed film 2 by the spin coater as 1st photopolymer film 8. Drawing 4 (b) applies 6000A (optical sensibility 40 mJ/cm²) of positive type photopolymers by the spin coater as 2nd photopolymer film 9 on the 1st photopolymer film 8. Drawing 4 (c) shows the cross-section configuration of the photopolymer after using and developing [expose and] the photo mask 10 for gray tones. The homogeneity of gray tone section thickness became good by the photopolymer thickness corresponding to the gray tone section 11 adjusting light exposure, and considering as the thickness of the 1st photopolymer film 8 exactly. If ultraviolet radiation for the non-shading section 12 with this sufficient is irradiated, since ultraviolet radiation will reach to the bottom of the 1st photopolymer film 8 and an alkali fusibility radical will be generated, all photopolymer film is removed. However, in the gray tone section 11, in order that there may also be an operation of the diffracted light and the quantity of light may decline, even the 1st photopolymer film is not reached. Especially, if the optical sensibility of the 2nd photopolymer film is better than the optical sensibility of the 1st photopolymer film, a clear difference will arise in generation of an alkali fusibility radical.

Therefore, only the 1st photopolymer film remains and it will become uniform as gray tone thickness. [0017] However, in order to apply a photopolymer directly [multiple-times], there is a problem of wettability and spreading of the 2nd photopolymer film is difficult. Drawing 5 is an approach for a wettability improvement, and applies the 1st photopolymer film of optical sensibility 80 mJ/cm² to the glass substrate which formed SiN and a-Si. Next, the solvent of the 2nd photopolymer film which is optical sensibility 40 mJ/cm² is applied, and the 2nd photopolymer film is applied after that. Next, prebaking, gray tone exposure, development, and a rinse are performed, and uniform gray tone thickness is created.

[0018]

[Effect of the Invention] According to this invention, the usual thickness section in gray tone exposure also serves as a uniform configuration as mentioned above the pattern of the gray tone section, or by usually devising the periphery pattern of the thickness section. Moreover, by using together the photopolymer with which optical sensibility differs, a clear photopolymer thickness difference can be produced in gray tone exposure, and uniform gray tone thickness can be obtained. Consequently, while stable processing is realizable, reduction of photo masks can be attained, and it is useful to process cost reduction, and very useful on industry. In addition, if this invention is used, since it will be useful also to development of the liquid crystal product which is the effectiveness and the energy saving device of saving-resources-izing, such as reduction of photo masks, it will be kind to earth environment and the space environment.

[Brief Description of the Drawings]

[Drawing 1] Drawing showing the pattern which realizes gray tone exposure of the gestalt of operation of this invention

[Drawing 2] Drawing showing the pattern which realizes gray tone exposure of the gestalt of other operations of this invention

[Drawing 3] Drawing showing the pattern which realizes gray tone exposure of the gestalt of other operations of this invention

[Drawing 4] Drawing showing the gestalt of the operation which makes gray tone thickness of this invention homogeneity

[Drawing 5] Drawing showing the flow of the gestalt of other operations which make gray tone thickness of this invention homogeneity

[Drawing 6] Drawing showing the pattern which realizes the conventional gray tone exposure

[Brief Description of Notations]

1 Usually, Thickness Section

2 Gray Tone Thickness Section

3 Protection-from-Light Section

4 Non-Shading Section

5 The Conventional Design Dimension

6 Design Dimension

8 1st Photopolymer Film

9 2nd Photopolymer Film

(19)日本国特許庁 (JP)

(12) 公開特許公報 (A)

(11)特許出願公開番号

特開2002-268200

(P2002-268200A)

(43)公開日 平成14年9月18日 (2002.9.18)

(51)Int.Cl.⁷

G 0 3 F 1/08
7/095
H 0 1 L 21/027

識別記号

F I

G 0 3 F 1/08
7/095
H 0 1 L 21/30

テマコード(参考)

G 2 H 0 2 5
2 H 0 9 5
5 0 2 P 5 F 0 4 6
5 7 3

審査請求 未請求 請求項の数 7 OL (全 5 頁)

(21)出願番号

特願2001-68948(P2001-68948)

(22)出願日

平成13年3月12日 (2001.3.12)

(71)出願人 000005821

松下電器産業株式会社

大阪府門真市大字門真1006番地

(72)発明者 武川 博三

大阪府門真市大字門真1006番地 松下電器
産業株式会社内

(74)代理人 100097445

弁理士 岩橋 文雄 (外2名)

F ターム(参考) 2H025 AA00 AB16 AB17 AC01 AD01

AD03 DA11 DA13 FA03 FA14

2H095 BB02 BC09

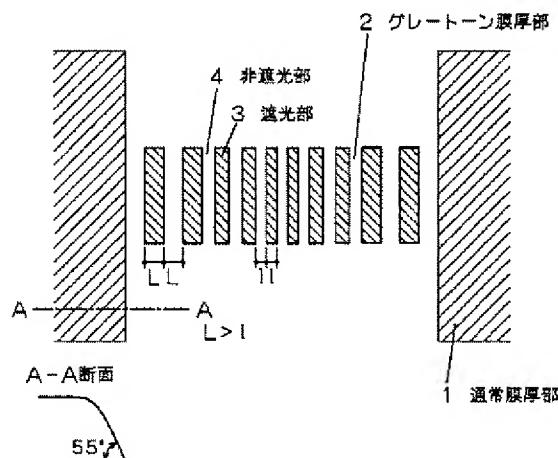
5F046 AA25 CB17 NA05

(54)【発明の名称】 グレートーン露光用フォトマスク及び感光性樹脂の塗布方法

(57)【要約】

【課題】 第1にグレートーン露光の近辺では通常膜厚部のテーパ角が小さくなること、第2にグレートーン膜厚の均一化を図ることは難しかった。

【解決手段】 第1に対してはグレートーン露光作成のパターン間隔を中央は狭く周辺は広くすること、第2に対しては光学感度の異なる感光性樹脂を複数回塗布し、上部の感光性樹脂のみ露光反応を促進されるようする。



【特許請求の範囲】

【請求項1】紫外光により感光性樹脂のパターニングを行うに際し、前記感光性樹脂のパターニングを行う露光機の解像度以下の寸法で形成された遮光部と非遮光部を繰り返して作成し、感光性樹脂の膜厚を複数作成する工程において、前記遮光部と非遮光部を繰り返す部分で通常の感光性樹脂の膜厚を形成する部分に近い部分は遠い部分に比べ、前記遮光部と非遮光部の幅が広いことを特徴とするグレートーン露光用フォトマスク。

【請求項2】通常の感光性樹脂の膜厚を形成する部分に近い部分と遠い部分の、前記遮光部幅に対する非遮光部幅の比率は同じである請求項1記載のグレートーン露光用フォトマスク。

【請求項3】ポジ型感光性樹脂を使用する前記通常の感光性樹脂の膜厚を形成する部分で、前記遮光部と非遮光部を繰り返す部分に隣接する部分以外の部分に、露光機の解像度以下の寸法幅の非遮光部を設け、かつ前記寸法幅の遮光部を設けるグレートーン露光用フォトマスク。

【請求項4】前記遮光部と非遮光部を繰り返す部分に面する通常の感光性樹脂膜厚を形成する部分の寸法を前記遮光部と非遮光部を繰り返す部分に面していない部分に比べ大きくするグレートーン露光用フォトマスク。

【請求項5】前記大きくする範囲は、少なくとも通常の感光性樹脂膜厚を形成する部分に接する前記遮光部と非遮光部を繰り返す部分の長さを、前記遮光部と非遮光部を繰り返す部分に隣接して設ける請求項4記載のグレートーン露光用フォトマスク。

【請求項6】紫外光により感光性樹脂のパターニングを行うに際し、被加工膜が成膜された基板に感光性樹脂を塗布した後、さらに前記感光性樹脂が塗布された前記基板面に前記感光性樹脂よりも光学感度が良い感光性樹脂を塗布することを特徴とする感光性樹脂の塗布方法。

【請求項7】前記基板面に前記感光性樹脂よりも光学感度が良い感光性樹脂を塗布する前に、前記光学感度が良い感光性樹脂の溶剤を塗布する請求項6記載の感光性樹脂の塗布方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、紫外光の透過率を段階的に変えるグレートーン用フォトマスクの作成方法と、グレートーン用フォトマスクを用いて、1回の露光で感光性樹脂の膜厚を複数作成するパターニング方法に関する。

【0002】

【従来の技術】近年、グレートーン露光と呼ばれる露光方法が実用化されている。従来の露光方法では感光性樹脂を残す部分と除去する部分のどちらかで、感光性樹脂の有無に応じてその下の被加工膜がパターニングされていた。これに対してグレートーン露光は多層の被加工膜を形成した後、一回の露光で従来の感光性樹脂を残す部

分、除去する部分に加え、残す部分の膜厚を薄くしたものを作成し、多層の被加工膜を一度にパターニングし、露光回数を減らそうとするものである。ここでグレートーン用フォトマスクを用いたパターニング方法は以下に示す工程で行われている。

【0003】①塗布：感光性樹脂を塗布する。

【0004】②プリベーク：塗布された感光性樹脂の溶剤を加熱、除去する。

【0005】③露光：グレートーン用フォトマスクを用いた露光を行う。

【0006】④現像、 rinsing：現像、洗浄を行う。

【0007】⑤ポストベーク：感光性樹脂中に残った現像液、洗浄液を加熱、除去する。

【0008】この結果、感光性樹脂はほぼ塗布した膜厚が残っている部分、全く除去された部分、それらの中間の膜厚を残した部分が作成される。この中間の膜厚とする部分のフォトマスクは通常、使用する露光機の解像度以下のパターンで構成し、透過する紫外光を低減、均一化している。

【0009】

【発明が解決しようとする課題】しかしながら、グレートーン露光を行った際、通常膜厚の感光性樹脂部のテーパ角がグレートーン露光部近傍かそうでないかにより異なるという問題があった。図6で、1は通常膜厚部、2はグレートーン膜厚部で、グレートーン膜厚部2に面する通常膜厚部1の端面はA-A断面に示すごとくテーパ角は α であり、グレートーン膜厚部に面しない通常膜厚部の端面はB-B断面に示すごとくテーパ角は β で、 $\beta > \alpha$ である。例えば露光機解像度3μm、2μm幅の遮光部、非遮光部を繰り返したパターンをポジ型感光性樹脂OFP R-5000（東京応化製）を用いて露光すると、 $\alpha = 60$ 度、 $\beta = 40$ 度となる。これはグレートーン露光部近傍は回折の影響が通常の露光部まで及び、感光性樹脂テーパ角を低下させている。テーパ角が異なるとエッチング時の寸法シフト量が変わり、仕上り形状が設計通りとならないことになる。またグレートーン部の感光性樹脂膜厚は基板面内でばらつくという問題があった。ポジ型感光性樹脂を例にとると、感光性樹脂に十分な紫外光が照射されると、溶解性の基を生成してアルカリ可溶となり溶解するが、紫外光の照射が少ないと上記反応が不十分なため部分的に溶解性の基ができたり、できなかつたりするため現像後の感光性樹脂膜厚の均一性が悪くなる。当然の事ながら、感光性樹脂膜厚が均一でないと加工精度が悪くなる。そこで本発明は上記の問題点に鑑み、グレートーン露光部を含む通常の露光部の仕上り形状とグレートーン露光部膜厚を均一に作成するフォトマスク、製造プロセスを提供することを目的とする。

【0010】

【課題を解決するための手段】上記のグレートーン露光

部を含む通常の露光部の仕上り形状を均一に作成する目的を達成するために、第一に感光性樹脂のパターニングを行う露光機の解像度以下の寸法で形成された遮光部と非遮光部を繰り返して作成し、感光性樹脂の膜厚を複数作成する工程において、前記遮光部と非遮光部を繰り返す部分で通常の感光性樹脂の膜厚を形成する部分に近い部分は遠い部分に比べ、前記遮光部と非遮光部の幅を広くするグレートーン露光用フォトマスクとすること、第二に通常の感光性樹脂の膜厚を形成する部分に近い部分と遠い部分の、前記遮光部幅に対する非遮光部幅の比率は同じであるグレートーン露光用フォトマスクとすること、第三にポジ型感光性樹脂を使用する前記通常の感光性樹脂の膜厚を形成する部分で、前記遮光部と非遮光部を繰り返す部分に隣接する部分以外の部分に、露光機の解像度以下の寸法幅の非遮光部を設け、かつ前記寸法幅の遮光部を設けるグレートーン露光用フォトマスクとすること、第四に前記遮光部と非遮光部を繰り返す部分に面する通常の感光性樹脂膜厚を形成する部分の寸法を前記遮光部と非遮光部を繰り返す部分に面していない部分に比べ大きくするグレートーン露光用フォトマスクとすること、さらには前記大きくする範囲は、少なくとも通常の感光性樹脂膜厚を形成する部分に接する前記遮光部と非遮光部を繰り返す部分の長さを、前記遮光部と非遮光部を繰り返す部分に隣接して設けるグレートーン露光用フォトマスクとすることである。また、グレートーン露光部膜厚を均一に作成する目的を達成するためには、第一に被加工膜が成膜された基板に感光性樹脂を塗布した後、さらに前記感光性樹脂が塗布された前記基板面に前記感光性樹脂よりも光学感度が良い感光性樹脂を塗布すること、第二に前記感光性樹脂よりも光学感度が良い感光性樹脂を塗布する前に、前記光学感度が良い感光性樹脂の溶剤を塗布することである。

【0011】

【発明の実施の形態】（実施の形態1）次に本発明の実施例を図面を用いて説明する。図1は本発明の実施例のグレートーン露光用フォトマスクのパターンを説明する図である。図1で感光性樹脂の通常膜厚部1より膜厚の薄いグレートーン膜厚部2を形成するために、使用する露光機の解像度以下の寸法幅の遮光部3と非遮光部4を繰り返したものである。ここで使用した露光機解像度は3 μm、グレートーン膜厚部2の中央部付近の遮光部3と非遮光部4の幅Lを1 μmとし、周辺（通常膜厚部1）に向かうに従いそれらの幅を0.5 μmづつ増し、最も通常膜厚部1に近い部分では幅L=2.5 μmとした。ガラス基板にTiを2000 Å成膜した上に、ポジ型感光性樹脂OFP R-5000を1.2 μm塗布し、露光、現像後SEM写真撮影を行いA-A断面のテーパ角を計測すると55度であった。

【0012】ここで隣接する遮光部3と非遮光部4の面積比率はグレートーン膜厚部の中央、周辺によらず一定

にする方がよい。場所により面積比率が異なるとグレートーン膜厚が変わり、平坦性が損なわれる。従って通常膜厚部1への距離にかかわらず、遮光部3と非遮光部4の幅の比率を同じにすることは必須である。

【0013】（実施の形態2）図2は本発明の他の実施例であるグレートーン露光用フォトマスクのパターンを説明する図である。図2で通常膜厚部1の周囲に露光機解像度以下の非遮光部4を設け、その周縁に遮光部3をパターニングしてある。本実施例においては1 μm幅の非遮光部と、1 μm幅の遮光部を設けている。この結果、通常膜厚部1の周縁のテーパ角はグレートーン膜厚部2に隣接した箇所も含めほぼ同じになった。

【0014】（実施の形態3）図3は本発明のさらに他の実施例であるグレートーン露光用フォトマスクのパターンを説明する図である。図3はグレートーン膜厚部2の周辺部の通常膜厚部1の設計寸法を大きくしたものである。従来設計寸法5として実線で示してあるが、グレートーン膜厚部2の周辺では通常膜厚部1のテーパ角が小さくなることから、エッチング加工後の寸法シフト量20が大きくなり、設計寸法より小さくなる。そのため通常膜厚部1のテーパ角が小さくなる範囲で設計寸法を大きくする必要があり、設計寸法6として破線で示してある。

【0015】なお、グレートーン膜厚部2の通常膜厚部1に隣接する長さがmのときは、少なくともその隣接する長さmの領域の通常膜厚部1にグレートーン露光の影響が及ぼされるので、この範囲で設計寸法を大きくする。

【0016】（実施の形態4）図4は本発明の実施例の感光性樹脂を複数回塗布し、グレートーン露光膜厚を均一化する方法を示したものである。図4(a)は被加工膜1としてSiNを3000 Å、被加工膜2としてa-Siを1500 Å成膜したガラス基板7に第1の感光性樹脂膜8としてポジ型感光性樹脂（光学感度8.0 mJ/cm²）をスピンドルコーターで6000 Å塗布したものである。図4(b)は第1の感光性樹脂膜8の上に第2の感光性樹脂膜9としてポジ型感光性樹脂（光学感度4.0 mJ/cm²）をスピンドルコーターで6000 Å塗布したものである。図4(c)はグレートーン用フォトマスク40を用いて露光、現像した後の感光性樹脂の断面形状を示したものである。グレートーン部11に対応する感光性樹脂膜厚は、露光量を調節してちょうど第1の感光性樹脂膜8の膜厚とすることによりグレートーン部膜厚の均一性が良くなつた。これは非遮光部12に十分な紫外光が照射されると、第1の感光性樹脂膜8の最下部まで紫外光が到達しアルカリ可溶性基が生成されるため、全ての感光性樹脂膜は除去される。ところが、グレートーン部11では回折光の作用もあり光量が減衰されるため、第1の感光性樹脂膜にまで到達しない。特に第2の感光性樹脂膜の光学感度が第1の感光性樹脂膜の光学感

度より良いと、アルカリ可溶性基の生成に明確な差が生じる。従って第1の感光性樹脂膜のみ残り、グレートーン膜厚として均一なものとなる。

【0017】しかしながら、感光性樹脂を複数回直接塗布するには、ぬれ性の問題があり第2の感光性樹脂膜の塗布が難しい。図5はぬれ性改善のための方法で、SiN_xを成膜したガラス基板に光学感度8.0mJ/cm²の第1の感光性樹脂膜を塗布する。次に、光学感度4.0mJ/cm²である第2の感光性樹脂膜の溶剤を塗布し、その後第2の感光性樹脂膜を塗布する。次にプリベーク、グレートーン露光、現像、リンスを行い、均一なグレートーン膜厚が作成される。

【0018】

【発明の効果】以上のように本発明によれば、グレートーン露光での通常膜厚部もグレートーン部のパターンあるいは通常膜厚部の周縁パターンを工夫することにより一様な形状となる。また、光学感度の異なる感光性樹脂を併用することにより、グレートーン露光で明確な感光性樹脂膜厚差を生じさせることができ、均一なグレートーン膜厚を得ることができる。その結果、安定な加工が実現できるとともにフォトマスクの削減が達成でき、プロセスコスト削減に役立ち、工業上極めて有用である。なお本発明を用いれば、フォトマスクの削減等省資源化の効果、ならびに省エネルギー機器である液晶製品の開

* 発にも役立つことから、地球環境、宇宙環境に優しいこととなる。

【図面の簡単な説明】

【図1】本発明の実施の形態のグレートーン露光を実現するパターンを示す図

【図2】本発明の他の実施の形態のグレートーン露光を実現するパターンを示す図

【図3】本発明の他の実施の形態のグレートーン露光を実現するパターンを示す図

10 【図4】本発明のグレートーン膜厚を均一にする実施の形態を示す図

【図5】本発明のグレートーン膜厚を均一にする他の実施の形態のフローを示す図

【図6】従来のグレートーン露光を実現するパターンを示す図

【符号の簡単な説明】

1 通常膜厚部

2 グレートーン膜厚部

3 遮光部

4 非遮光部

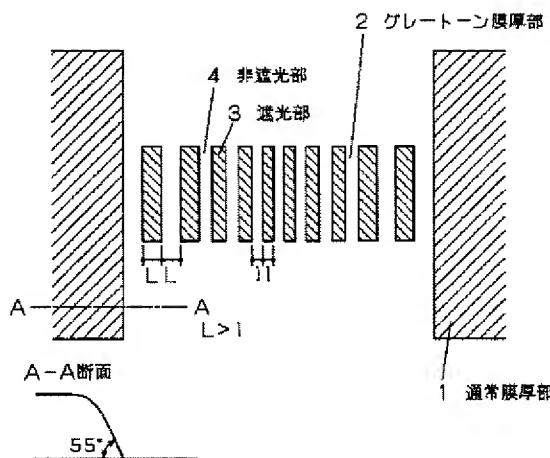
5 従来設計寸法

6 設計寸法

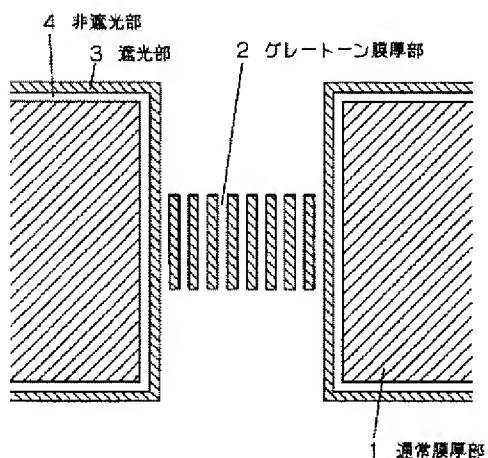
8 第1の感光性樹脂膜

9 第2の感光性樹脂膜

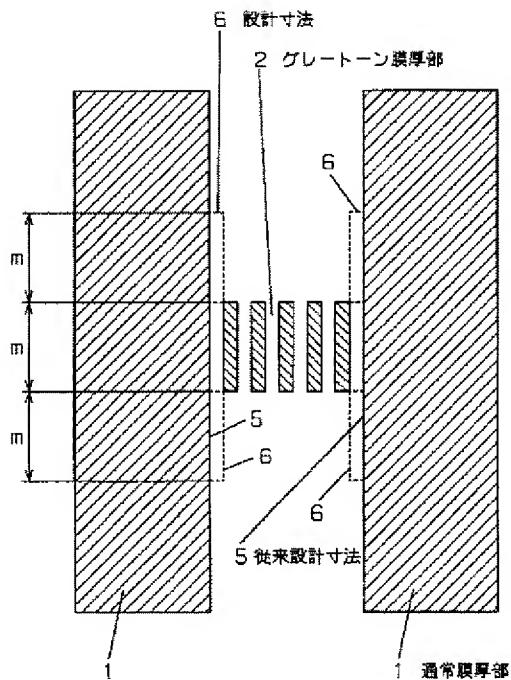
【図1】



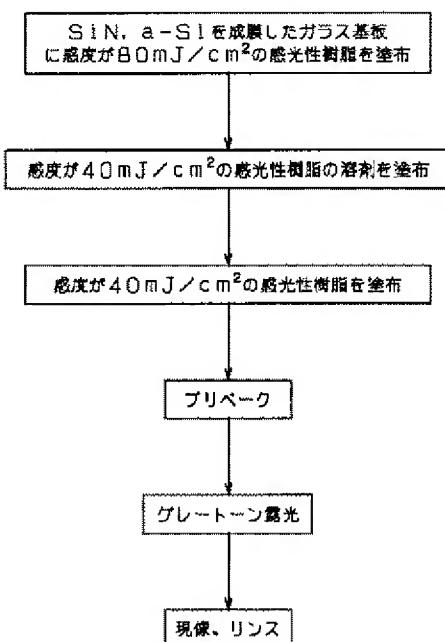
【図2】



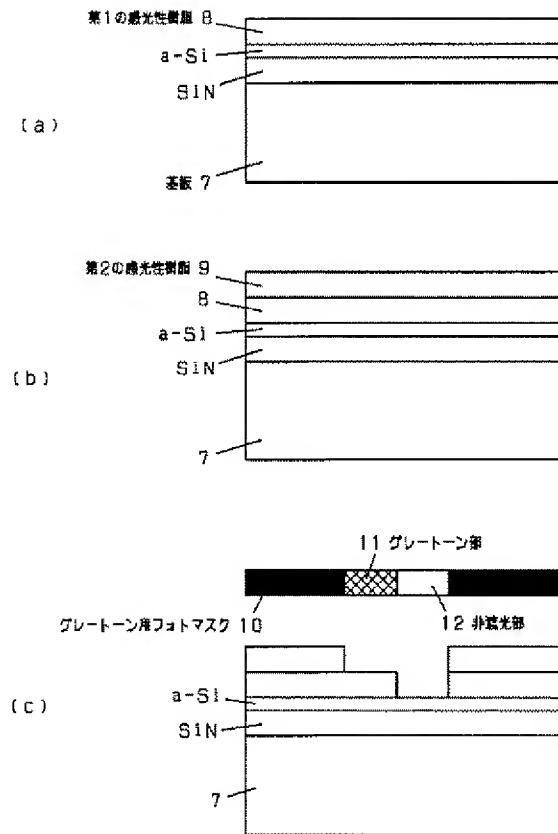
【図3】



【図5】



【図4】



【図6】

